EXHIBIT AA

DECLARATION OF CARMEN LUCAS

I, CARMEN LUCAS, DECLARE AND STATE AS FOLLOWS:

1. I am a Kwaaymii Laguna Band of Indians Tribal member and experienced Native American Monitor, my qualifications and background are more fully set forth in my paper "Sacrifice Areas," Exhibit 19 to the Memorandum of Points and Authorities in Support of the Temporary Restraining Order, and are incorporated herein. I have personal knowledge of the facts stated below, and will be at the hearing Monday should there be no construction work at the property. If called to testify, I would and could testify competently thereto.

2. I want to talk about three aspects of the project: first, the drawing of the limits of construction line on the project property Thursday, second, what I have observed at the property as the Viejas (MLD) representative and third, the difference of philosophy between archaeologists and Indian People as it is relevant to the project and how the core or sensitive area was developed.

DRAWING OF THE LINES

3. I was at the Court hearing on Thursday in this matter and went out to the property that afternoon when the Court directed the District and Viejas to attempt to agree where to mark the line where work would be off limits pending a decision on the temporary restraining order for the project.

4. When we got to the property about 3:45 pm, I was very surprised to see that machines had already been working onsite that

day and had already disturbed the ground right up to the southern tip of the area Mr. Gilpin said in Court was the edge of the sensitive area according to the District which had fencing to mark it. This is an area I had just expressed concern about while at the Court because ASM didn't do any testing there, and this is where the archaic points came from which are indicative of great antiquity. Onsite, I wanted to bring the fencing out from that tip at least another two or three feet to the south, but Mr. Gilpin, who appeared to be directing decision making for the District, firmly would not agree.

5. To help in making the line, I surveyed the ground roughly along but inside the southern end of the recorded archaeological site. To the immediate west of the tip, I found a mano (the first instrument we use in our digestive system to ground seeds, break up bones to get at the marrow and grind the clay to make pots so that we may put the broken cremated remains into them, etc.) that had fresh scrape marks on it from the scraper. I showed this to those present and made sure it was within the line.

6. I then made the line further to the west to the existing property fence line. The District people initially objected because they felt it was all debris or disturbed. It should be noted that in the earlier onsite archaeological work I participated in, we did not really investigate that area to the west at all but based upon my experience, I am concerned about what may be found there under all the trash.

7. For the line to the east, I wanted to make it come up from the tip closer to the south gate area to include a grassy area. This is because there was a pepper tree and shrubbery there when ASM did their data recovery, which impeded our ability to see what was on or

in the ground, but which has since been removed. I was, and remain concerned, that there is midden soil there with a high potential for human remains. Mr. Gilpin firmly would not accept going that far to the south, so the line went to approximately where the telephone pole is.

8. Regarding the north point of the property (the downhill end), where a large excavator was already located on Thursday to my great dismay, I could not agree to any work there because of the likelihood that additional items of concern may have been deposited there including due to natural factors such as erosion. Plus, when I was walking down there with Mr. Gilpin I observed pottery, chipped stone and even though it was on the neighboring property, the milling features on the rock outcrop there were glistening. None of these items were recorded or collected at this time. When the District initially objected, I told them that the Old Ones did not know what property lines were and they used the landscape in their entirety.

9. I felt I did the best I could under the circumstances and the great pressure I was receiving from Mr. Gilpin and the many District personnel present to minimize the area ribboned off and the need to report back to the Court with our progress by 5:00 pm to try and protect any part of the project from being destroyed prior to the TRO hearing.

10. I was not, and still am not, comfortable about the areas to the immediate south of the tip not being included within the protection line. During excavation on Saturday, in fact, a burned pottery sherd, in my opinion a grave good associated with cremation, was located by Viejas Observer Frank Brown in this area. [See exhibit A attached recent finds map]. As the MLD representative, I collected

this sherd at the end of the day Saturday for safekeeping. I suspect there may be additional human remains, grave goods and ceremonial items in that area.

11. I was not, and still am not comfortable about the area north of the south gate. During construction on Friday, the Viejas Observer Frank Brown found a burned bone (indicating a potentially cremated human remain) with micro flakes of quartz and felspar (potential grave goods or ceremonial items) in close proximity. [See exhibit A attached recent finds map]. As the MLD representative, I collected the bone fragment but the flakes were not collected and should still be there. I suspect there may be additional human remains, grave goods and ceremonial items there.

12. I also have some concern about the large area presently being excavated to the south, as that area was never the subject of archaeological or tribal investigation, testing or data recovery, and was only examined as to its historicity relative to the structure that apparently was once there. It has been very difficult to truly monitor the soils in the south end as they are being excavated because of the great volume the skip loader picks up and puts in the truck and the swing of the bucket being 30 feet as I need to stay at least that far away from the earth movers and the truck for safety so it is foolish to think that anyone can really monitor what's coming out of the ground there. Also, because of the clay nature of the soils, it is difficult, if not impossible, to locate fragmented bone or other items without the use of water screening of the soils due to clumping. Nonetheless, I found a possible quartz flake or shatter (cultural materials from someone making a stone tool) in this area. [See exhibit A attached recent finds map]. I asked that if the onsite archaeologist

was not sure it was cultural, that he collect it and take it back to ASM so that Mark Becker, PhD, lithic expert could examine it. I did collect it and it remains in my possession for safekeeping. I suspect there may be additional human remains, grave goods and ceremonial items in that southern area where the soils, about 180 truck loads, were excavated Friday and Saturday down to bedrock and taken off the property.

13. Additionally, I have concerns about the area just to the west of the existing paved road running along the east property line. The current conditions I observed there include midden soils reaching to the road. In fact, I found a pottery sherd in this area [See exhibit A attached recent finds map] on Thursday, outside the property fence line. I understand that tribal cultural materials have been found at the mobile home park next door and have heard that utility contractors encountered items in the road area about 10 years ago when working there.

14. It is my informed opinion as the Tribal Monitor most familiar with the property, that the entire property and its soils represent a tribal burial ground and ceremonial site and should not be further disturbed and should be protected. For me, as a local Indian, it is a spiritual violation for parts of a burial (such as a cremated bone) to be moved from a property (its final resting place) and separated from the other parts of the burial (other bone fragments, grave goods, associated other burials, i.e., family members, etc.). This means that the spirit may be left to wander looking for the rest of its burial. Moreover, even if you were able to pick up all the bone and grave goods, the ashes of the individual and other essences will remain in the soil and never be repatriated. This too is a spiritual

violation of the highest order. In this modern day and age, there may be times when it can be appropriate to repatriate isolated or unanticipated finds, but the repatriation of parts of pieces of a burial ground is another matter, an insane process.

15. Furthermore, the old ones often thought about the whole of the area when they buried their family members. It's not just the actual location of the burial itself that is important but also its context, its landscape. I certainly considered that when I buried my father on our ancestral lands, as did he for his mother in burying her, and she for her mother, and so on. They rest together along the ancestral route between the mountains and desert lands. Here, when on the project property, one can see to El Capitan, a sacred mountain, and feel that same type of connection to the landscape and the journeys between one sacred place to another and part of the corridor from coast (Pacific Ocean) to coast (Colorado River) and may still hold the lingering spirits of those who do not want to go yet to that final resting place.

16. Finally, from what I have observed at this property in the three years I have been familiar with it, is that construction site activity prior to work recommencement within the area marked off limits, and possibly elsewhere on the property, may have spread human remains, grave goods and ceremonial items.

17. In sum, it is my strong recommendation based on what I have seen at the property, including over the last three days, that construction be stopped on the whole property; but if the whole of the property is not to be protected by a TRO, then the no work line be should be moved at least five to ten feet to the south of where it stands today, Sunday.

MY EXPERIENCE TO DATE AS THE VIEJAS (MLD) REPRESENTATIVE AT THE PROJECT SITE

18. I went to the project site Friday morning as a courtesy to Viejas (I am not being paid by Viejas, nor any other party to be there), and under protest, as I believe it is a spiritual violation to dig up the burials of our ancestors, but I strongly believed -- and still do - that sites having important tribal cultural significance need to be monitored by knowledgeable and qualified monitors with a trained eye for seeing the resource and to offer up prayers asking for forgiveness as I cannot help what this society does.

19. I had been told that construction was going to be allowed to proceed by the Court on the south end of the property pending the outcome of the hearing on the temporary restraining order, and that Padre Dam agreed that Viejas could have its representative at the project site and one "Native American Observer" for every piece of earth-moving equipment being used. I was designated by Viejas as being the representative. I was also told that I had to communicate through the Native American Monitor hired by the District's consultant, ASM, to monitor the construction activities. I was also told to be professional and not act without cause to disrupt the construction. I have acted professionally, even though this has been the most trying project I have encountered in my entire career, and that includes twenty years in the United States Marine Corps. I have endured being yelled at repeatedly on the project site by one of the onsite project managers, treated as though I am dishonest, and made to feel unwelcome on the property by other project personnel, including the use of video and still cameras trained on me, but I have made

every effort to keep my composure so I may continue onsite. It is clear to me that they would prefer me not to be present.

20. I want to address two issues that I understand the District raised about my presence on Friday, first that I was somehow "wandering" in the area that was "ribboned off." In fact, I went into the "ribboned-off" area, a recorded Kumeyaay cultural site, (sometime after the Native American Monitor did) to check on tribal cultural materials that apparently were placed there after data recovery had concluded but before the constraction work stopped in February, and probably during the blasting of the milling feature. On Friday I saw a pile of about 6 -8 manos, a cut animal knuckle, a small jawbone of an animal, six very old marine shells, and a large quartz point. I also said a prayer of forgiveness to the ancestors for the disruptions to them and that I am so sorry for what is going on today. As the MLD representative, I went into this area to also confirm that no construction activity was currently taking place there or that no one was pot hunting.

21. I understand it was also stated that I moved the ribbon after the suspect bone was found. This is not the case, the ribbon was moved by the ASM Native American Monitor or at his direction, after the bone fragment was found, to ensure that the area in which it was found was put outside the area of construction activity at least until a determination by the Coroner as to whether it is human. It is my opinion that is consistent with what is required by the MMRP for this project.

22. It is evident to me that many of the personnel on the project do not understand what the job of an MLD representative is: It is my job to look at the ground, examine travel routes of the export trucks, the location where the soil export is dumped, to do my best to identify human remains, grave goods and ceremonial items, if present, see that they are treated in a culturally-appropriate, respectful and sensitive manner and that the conditions of project approval are followed.

23. On Friday I examined the route of the three dump trucks exporting soils to see what may have fallen out along the road or be visible within the piles at the storage yard. I also began to examine the piles which contained many items of historical archaeology (such as 1964 Clorox bottle and coke bottles). However, on Saturday, a newly posted security guard denied me access to the export dump site, access to which is an opportunity to more closely observe potential cultural material than at the excavation site (because of the previously stated work scale and safety concerns related to large scale excavation) to determine if there may be tribal cultural items of interest present in the soils.

24. Also on Saturday, a skip loader was added to the export area and was moving the excavated materials around on the temporary site. I am concerned that this could cause a mixing of soils, which could make it more difficult to identify materials of interest and also not allow for the identification of the specific locations onsite from where it came. He was also compacting it down, which could compromise the integrity of any cultural items in them. The skip loader stopped work later in day, I was informed, after Viejas complained about the denial of access to me and the potential impact

of the skip loader on the soils. Starting Saturday, the District also requested that I and the Viejas Observer were to observe only in the areas marked for construction. I complied with this request to keep the peace during this interim period even though it is inconsistent with what my job is at the property.

25. It has also become very evident to me that the onsite archaeologists and Native Monitor lack a practical plan of action or protocols for finds on the property which has resulted in some confusion, uncertainty and delay in responding to the cultural discoveries recently made onsite. This includes: the onsite archaeologists not having basic and proper equipment, such as screens to sift soil in the vicinity of finds; the onsite archaeologist for Saturday not having read the project reports, lacking familiarity with the site, not having a GPS unit and not being briefed on the project; a general lack of familiarity with the Mitigation, Monitoring and Reporting Program and its requirements, such as to contact the Coroner if human bone is found; no practical protocol of what to do when finds are made; no clear statement regarding collection of finds; and no predetermined chain of custody for human remains or for obtaining a positive identification from the Coroner's Office. Simply put, they were not prepared to stop work if they had to.

26. I understand that once the existence of the lack of protocols had the potential to cause resource harm on Saturday, that Viejas, the MLD, presented the District's counsel with interim protocols for work in the southern area which I underatand include: 1) All work cease in the area of the find; 2) That the find be documented; 3) That the onsite archaeologist, monitor and observers be allowed adequate time to investigate the area for additional and

associated items; 4) That if and when the area is cleared for work to recommence, that the items be collected in a culturally appropriate manner and be given to the MLD representative or her designee; and 5) That if the soils in the area must be moved, that they be moved to another location on the property (not moved off site) within the allowable construction area, for additional investigation and to ensure segregation.

27. I took possession of the discovered burned bone fragment found on the site Friday afternoon, after the find area and the bone had been documented by the onsite archaeologist and Native American Monitor including the taking of a GPS point. I felt that given the legal cloud over the project, that to ensure the bone was not somehow damaged, lost, stepped upon or potentially treated in some other culturally inappropriate way, that it should be collected to ensure proper identification by the Coroner as required in the MMRP.

28. Because no one would initially call the Coroner, I attempted to contact both the Coroner's Office generally and Dr. Hinkes specifically (who made the positive identifications of human bone onsite in 2009 on behalf of that office) on Friday, without success. I understand that Micah Hale (ASM principal investigator for the data recovery project) also contacted Dr. Hinkes on Friday and that she is scheduled to come out to the property Monday morning to meet with us and attempt to positively identify the suspected bone fragment.

29. The onsite archaeologist on Friday stated that he felt the bone could be human cremation as it is consistent with the bones found during the 2009 data recovery work which were positively identified as human by Dr. Hinkes and appears consistent with cremated human bone.

DIFFERENCE OF PHILOSOPHY

30. I understand Mr. Gilpin asserted in Court that ASM's work narrowed the area of sensitivity on the property and used the core area blue line as the boundary for that.

31. I was advised during data recovery by ASM archaeologists that the core area concept was developed by them based on the forensic dog interest near the bedrock feature and all the potsherds near the feature, for the purposes of data recovery which is a scientific interest, not an Indian interest.

32. During testing and data recovery the grass was so thick that ground visibility was close to zero and this made detection more difficult for the dogs, the archaeologists and the Indians.

33. During data recovery, I moved the grass and found flakes and sherds and I asked that a test unit be put out closer to the eastern property fence line. That area became test unit 29 (outside the core area) in which human remains and tribal cultural items were found (outside the core area). Additional test units outside the core area should have happened for both scientific and tribal reasons, but did not occur, even after I questioned it. So, to say that the archaeological work somehow narrowed the area of significance is very misleading to say the least. In fact, the work actually confirmed what had been said by the two Native American Monitors in 2007 about the extensive tribal values of the property wholly apart from the archeological point of view.

34. This is indicative of how the archaeologists and Indians view these things from different philosophies. One from samples of data and black and white lines and the other from the way that we actually utilized our cultural landscape.

I declare under penalty of perjury pursuant to the law of the State of California that the foregoing is true and correct.

Executed the 6 June, 2010, at San Diego, California.

Carmen Lucas


ENTRANCE
FORMER ROCK WALL.
mano
EXH. A RECENT FINDS MAP

EXHIBIT BB

SECOND DECLARATION OF FRANK BROWN

Dated this June 5_, 2010

I, FRANK BROWN, DECLARE AND STATE AS FOLLOWS:

1. I am a Viejas Tribal member and Monitor, and have personal knowledge of the facts stated below and if called to testify, I would and could testify competently to the facts stated below.

2. I went to the project site Friday morning to serve as a Viejas Native American Observer as requested by Viejas Tribal Vice-Chairman Welch on June 4, 2010. I had been told that construction was going to be allowed to proceed by the Court on the south end of the property until the outcome of the hearing on the temporary restraining order was decided, and that Padre Dam agreed that Viejas could have its representative at the project site and one "Native American Observer" for every piece of earth-moving equipment being used during the day. Carmen Lucas was designated by Viejas as being the representative, and I was asked to be one of the Observers. I was also told that I had to communicate through the Native American Monitor hired by the District's consultant ASM to monitor the construction activities for the entire project. I was also told I needed to be professional on the site and not act without cause to disrupt construction.

2. I agreed to go to the site as an Observer but I was doing it under protest because I believe there are more tribal

cultural resources -- including more human remains-- on that site and I don't think it's right for us to be disturbing it any more than it already is. I agreed to go anyway, though, because I want to make sure we can properly identify and protect whatever else might be there.

3. When I got up there I talked to Howard Cuero, the Native American Monitor. He's my cousin, and we call him Howie. I was asking him what he knew about the site and it was clear he didn't really know very much about it. I asked him if he knew about all the bones that were found, and Howie told me he knew that a few small fragments had been found, but that was all. I asked him if he knew that there were over 200 bones found at the site and he acted surprised and said no. After that conversation, he was on the phone all day talking with people he thought might know something at the site, and I think he was trying to find out as much as he could about what was found before he was asked to be the monitor.

4. Howie and I just talked for a while, and Howie told me that he heard the reason I didn't take the job as the Native American Monitor was because I was busy working for the Fire Department. I told Howard that the reason I didn't take the job was because I knew as soon as I got to the site the very first time in mid-December 2009, that it was a burial site and didn't want to have any part of digging up the ancestors that were there.

5. I asked Howie about the declaration he signed that disputed what Carmen Lucas, Clint Linton and I had said about the tribal cultural value of the site, and said that the site

was just a watering hole and not a burial or cremation site. Howie said he didn't write any such thing. I said, "Yeah you did -- Padre Dam sent a copy to the Native American Heritage Commission with your name on it" and Howie said he didn't sign anything and he didn't know what I was talking about. He said a couple of times he didn't know anything about it and didn't sign anything like that, but then today he said he did sign it.

6. While I was out at the site Friday with him and Carmen, I was kind of worried because it was clear that Howie didn't know a lot about the site before he got there. For example, Howie said that when he was first hired by ASM, he was supposed to just monitor the work on the milling site, and if any bones, grave goods or other artifacts were found, he was supposed to call the Coroner and then call Clint Linton to pick it up. When we found the bone yesterday, he didn't know what to do. That's how they are working up there with this stuff. There are no bags or anything so if they find anything, Howie just sticks it in his backpack. Brad Comeau, the ASM archaeologist didn't have a clipboard or a GPS or anything.

7. On Friday I walked the site and I went to an area of dark midden soil. In the late afternoon, I was standing in the area with the midden soil talking on the phone and I looked down and I saw a bone fragment. I got Carmen and Howie to come over and I showed them what I found and Carmen right away said that was cremated bone. Then we started looking really closely at the ground and we found another bone fragment. I also found a bunch of flakes, arrows, and today I found a piece of pottery.

Carmen found some flakes up near where the brick wall was. There are things all over the place in the midden soil.

8. The midden soil where I found the bone is up at the fence line just north of the south gate, in a weedy area outside of the area I understand the District and Viejas roped off Thursday as off limits to construction, talking on the phone, when I found a bone fragment. It was really small, and while I could tell it was bone, I wasn't sure if it was human or not, but because of the pressure flakes that were there with it, I thought it probably was human, as this could indicate a cremation. I told Carmen what I found and showed it to her, and then I showed it to Howie and Brad, the ASM archaeologist on site. I told Howie that because we thought it might be human, he had to call the Coroner to get the bone identified. Howie wasn't sure what the procedure was for that, so he called Micah Hale at ASM to find out what he had to do. He also called Steve Banegas at KCRC to find out who the MLD was. I don't know if he actually talked to Steve, but I told him the MLD was Viejas.

9. After I found the bone, I was looking around that area to see if there was anything else there and I was explaining to Howie what I was looking for and why. Because he only has about seven years experience as a monitor and has never dealt with human remains I was trying to show him what to look for so he would know. I've been trying to help him as much as I can. I kind of felt like there was a lot of stuff being overlooked that might be important, and I was worried that when the excavation actually started in this area, there was going to be

a lot of material impacted or missed. Howie put up stakes and pink flagging where we found the bone. I was surprised that the ASM archaeologist and monitor did not appear to have an onsite plan in place for who and when the Coroner would be called as this is typically a basic part of the procedure, especially when there has already been human bone found on a project.

10. It is my opinion that the construction site activity before work started again and possibly elsewhere on the property spread human remains, grave goods and ceremonial items across the site.

I DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE STATE OF CALIFORNIA THAT THE FOREGOING IS TRUE AND CORRECT AND THAT THIS DECLARATION WAS SIGNED ON June 5, 2010 AT ALPINE, CALIFORNIA.

FRANK BROWN

EXHIBIT CC

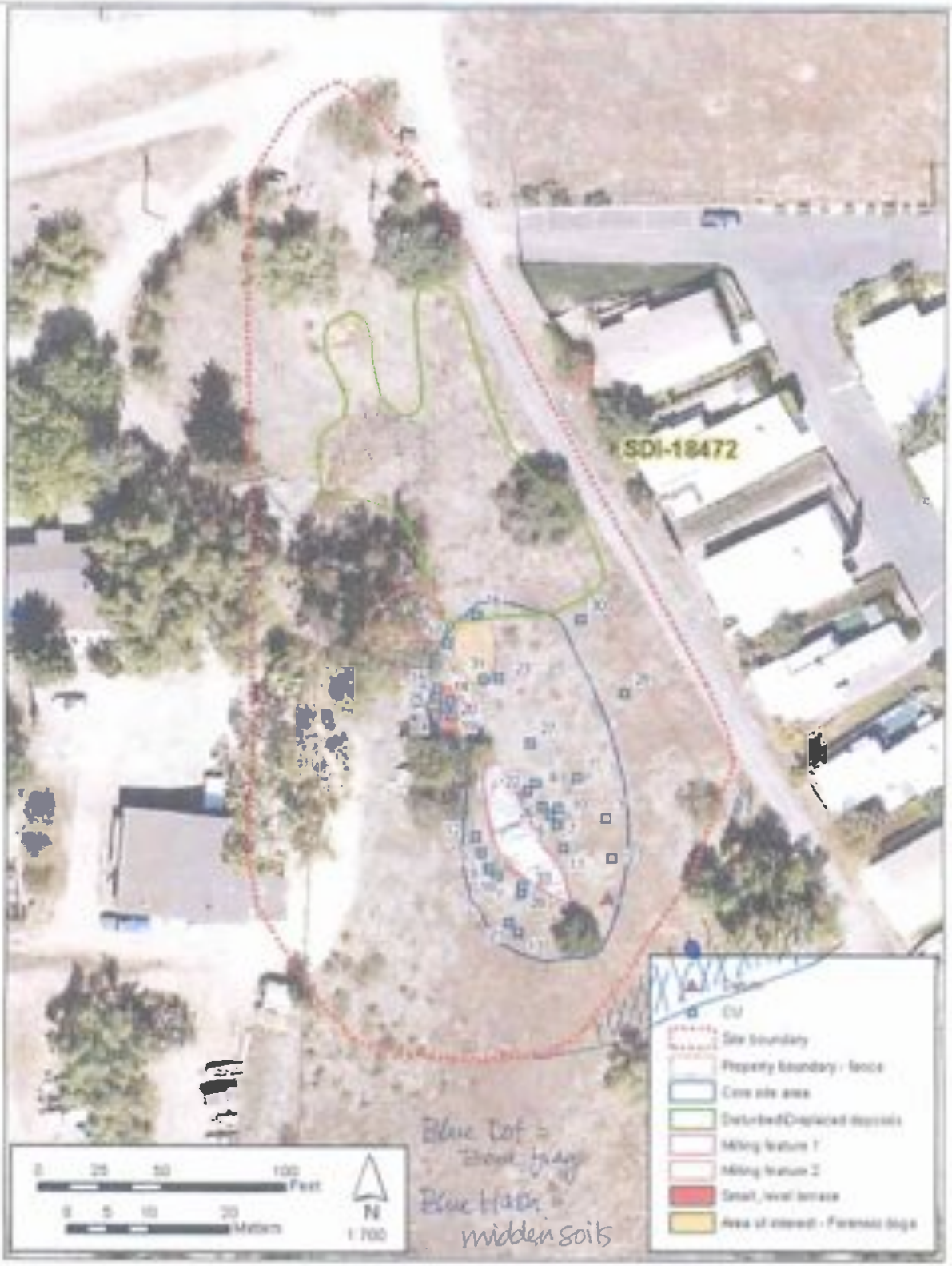


Figure 6.1 Map of SDI-18472 showing the locations of data recovery units in relation to the core site area.

Padre Dam Secondary Connection - Reduced Impact Area

EXHIBIT DD

Mission Statement

To protect and preserve ancestral remains, sacred lands and sacred objects under the Native American and Graves Protection Act (NAGPRA) for today and future generations.

Member Tribes

Barona Campo Ewiiaapaayp Inaja Jamul

La Posta Manzanita Mesa Grande

San Pasqual Santa Ysabel Sycuan Viejas

Steve Banegas, Spokesman

Kumeyaay Cultural Repatriation Committee

June 2, 2010

President Dan McMillan
Padre Dam Municipal Water District
Board of Directors
P.O. Box 719003
Santee, CA 92072

Dear President McMillan:

I am writing to correct several false statements made by Padre Dam representatives that have recently come to our attention, including through public media as the San Diego Union Tribune.

First, in the most recent submission to the Native American Heritage Commission, and in a letter dated May 21, 2010 (to Dave Singleton), your attorney states that the delegation of Viejas as the MLD for the Ridge Hill Project was the result of a "disagreement" between KCRC and Viejas. This is a false statement. There has never been a disagreement between KCRC and Viejas. The designation resulted from a request by Viejas, who identified themselves as those most likely to be culturally affiliated with those who had been, and are, buried at the site. KCRC agreed that in light of Viejas' belief—and misrepresentations by Padre Dam (discussed below)—- that Viejas should be designated MLD.

Secondly, Padre Dam repeatedly relies on an alleged "agreement" between KCRC and Padre Dam regarding mitigation of tribal cultural resource impacts and construction on the site. KCRC delegated its authority to Viejas as MLD and therefore Viejas is considered the decision-making representative relating to the tribal cultural resources at this site. KCRC defers any decisions relating to tribal cultural resources at the project site to Viejas. KCRC encourages Padre to make every effort to come to a resolution relating to this project site and to the treatment of any other human remains, grave goods, or other associated objects.

Thirdly, Padre Dam repeatedly has misconstrued the nature of the prayer held at the project site: this was not a "blessing" of the project or the District providing the District with permission to move forward with the project and desecrating a burial and ceremonial site. Instead, this was a prayer asking our ancestors for forgiveness on our behalf for not being able to stop the disturbance of buried ancestors in this day and time..

1095 Barona Road Lakeside, CA 92040 • Phone 619-443-6612 or 390-1588 Fax 619-443-0681

Finally, in the time that has elapsed since our last meeting with Padre Dam, more information has been revealed to KCRC about the nature of the discoveries at the current project site. We believe that Padre Dam at its meeting with KCRC on September 9, 2009 deliberately provided to KCRC incomplete and misleading information about the project to further its purpose, including:

1. representing that the property was private land, not public land;

2. representing that only 14 bone fragments were found—and not indicating that those fragments represented between 3 and 8 different individuals and that the unidentified bone could indicate additional individuals;

3. failure to indicate the unusually high concentration of pottery sherds at the site, which indicate to Kumeyaay peoples that this is a cremation and burial site; and

4. failure to share with KCRC that there were at least two alternative on-site designs, and at least two off-site alternative locations for the project;

5. failure to tell us the whole property would be torn up.

KCRC did not have all the relevant information, and therefore could not have made a fully informed recommendation about mitigation of tribal cultural resources impacts at the site. If the full extent of the human remains, grave goods, and other associated artifacts had been revealed to us in a timely manner, KCRC would have recommended avoidance of the project site altogether. In fact KCRC's letter to the District clearly stated, "It is KCRC intention to preserve as much of this site as possible." Even during our discussions with Padre Dam several delegates warned that there was more to this site, and voiced their opinions that the project should be moved. Any shame is not on KCRC or Viejas, but on the District for how it selectively presented the information to us and how it continues to downplay the impacts to others after being told what this place means to us.

Despite Padre Dam's statements to the contrary, KCRC never gave Padre Dam permission to destroy the site as they have done. In fact, delegates were shocked when they did a site visit in December 2009 at how the site had been treated and impacted. Any mitigation recommendations were made by KCRC *if* Padre could not avoid the current site and preserve as much of the site as possible. To date, Padre has never provided any information that that avoidance of the site was not an option.

KCRC understands that this project is important. However, Padre Dam, as a public agency, is required to follow all applicable law when carrying out a project to benefit the public. KCRC was misled. We urge you to continue negotiations with Viejas, the current MLD, to amicably resolve this issue, including potential recommendations on how to appropriately treat the property and how it should be monitored, if any project work continues, and KCRC urges the District to remove this project to an alternative site.

KCRC has lost trust in the District. It is our hope that the District will in the future provide KCRC with full and accurate information, describing and analyzing the resources in a way that is meaningful to local tribal people, not just archaeologists. We also hope the District will adopt policies and procedures so that the destruction of our burial grounds and ceremonial areas can be avoided on future projects.

Sincerely,

Steve Banegas

Steve Banegas, Spokesman
Kumeyaay Cultural Repatriation Committee

cc: Larry Myers, NAHC
Chairman Bobby Barrett, Viejas

EXHIBIT EE

Mission Statement

To protect and preserve ancestral remains, sacred lands and sacred objects under the Native American and Graves Protection Act (NAGPRA) for today and future generations.

Member Tribes

Barona Campo Ewiiaapaayp Inaja Jamul
La Posta Manzanita Mesa Grande
San Pasqual Santa Ysabel Sycuan Viejas
Steve Banegas Spokesman

Kumeyaay Cultural Repatriation Committee

NATIVE AMERICAN HERITAGE COMMISSION
PUBLIC HEARING
May 12, 2010

DECLARATION OF STEVE BANEGAS IN SUPPORT OF A REQUEST BY THE VIEJAS BAND OF KUMEYAAY INDIANS THAT THE NAHC MAKE FINDINGS THAT THE SECONDARY CONNECTION PROJECT SITE CONTAINS A SANCTIFIED INDIAN BURIAL AND CERMONIAL SITE

May 10, 2010

I, STEVE BANEGAS, DECLARE AND STATE AS FOLLOW:

I am the Spokesman of the Kumeyaay Cultural Repatriation Committee, which is also known as KCRC. KCRC is a consortium of the Barona, Campo, Ewiiaapaayp, Inaja, Jamul, La Posta, Manzanita, Mesa Grande, San Pasqual, Santa Ysabel, Sycuan and Viejas Bands of the Kumeyaay Nation. I have been involved with KCRC and repatriation since 1997. I am a Tribal member of the Barona Band of Mission Indians.

The Kumeyaay Cultural Repatriation Committee was formed in 1997 for the purpose of repatriating human remains, artifacts and objects of cultural patrimony to the twelve Kumeyaay Tribes of San Diego. KCRC continues the work on repatriation started by Ewiiaapaayp Tribal Chairman Tony Pinto and other tribal leaders after the passage of the Native American Graves Protection and Repatriation Act (NAGPRA).

KCRC meets once a month on the first Thursday of the month at 10:00 am to discuss repatriation activities and organize site visits for the purpose viewing collections and sites. Tribes volunteer to host the meetings. Everything is done on volunteer basis.

On September 5, 2009, representatives of Padre Dam attended a KCRC meeting on the Viejas Reservation, Viejas being the meeting host for that month. The presentation Padre Dam gave was to inform KCRC about the project they wanted to do near Lake Jennings. Padre Dam showed us a power point presentation which included a project-site drawing, and discussed some of the cultural resources found at the site.

1095 Barona Road Lakeside, CA 92040 • Phone 619-443-6612 or 390-1585 Fax 619-443-0681

On September 5, 2009, representatives of Padre Dam attended a KCRC meeting on the Viejas Reservation, Viejas being the meeting host for that month. The presentation Padre Dam gave was to inform KCRC about the project they wanted to do near Lake Jennings. Padre Dam showed us a power point presentation which included a project-site drawing, and discussed some of the cultural resources found at the site.

Padre Dam told us the land there was private land, not public land. A lot of the tribal representatives at that meeting didn't think they could do anything with regard to the project because it was on private land. Even so, several of the delegates told Padre Dam not to destroy the site. The representatives felt that every time agencies wanted to do a project and needed land they would get private land, which keeps Kumeyaay people from doing anything to protect the cultural resources. It wasn't until much later that we found out that the project site is actually public land because it's now owned by Padre Dam, a public agency.

KCRC representatives received a copy of the cultural resource report at this meeting. One of the KCRC delegates asked Padre Dam if remains had been found on the property prior to the purchase of the land. The answer was yes. Padre Dam told us about the history of the property and what was found there. They told us that there were only 14 pieces of human remain fragments found in the testing pits they recently tested. Native American monitors present at the meeting voiced there is a good chance more human remain fragments would be discovered and the land should be considered an Indian burial ground. Padre Dam seems to have ignored the Native American monitors present at the site. KCRC knew there were more than one archeological firm associated with the project and there had been problems, but KCRC thought at the time we couldn't do anything because we were mislead to believe the property was private land. Pad Dam also never told KCRC at this meeting that there were both potential on-site and off-site alternatives for the project. KCRC feels the Padre Dam Water Authority misrepresented the information about the cultural resources, public lands, and potential off-site alternatives for this project.

The only reason KCRC made recommendations with regard to the Padre Dam Water Authority project was we believed there were only 14 fragments found at the site. KCRC did not give Pare Dam Water Authority permission to destroy the site. In a letter dated October 13, 2009 KCRC made requests with the intentions to preserve as much of this site as possible.

When Viejas came to KCRC with their concerns in 2010, the KCRC delegates made decision at the February 4, 2010 monthly meeting, to turn the MLD designation over to Viejas. On February 8, 2010, KCRC simultaneously conveyed the MLD transfer information in a letter to Viejas Band of Kumeyaay Indians and Native American Heritage Commission.

KCRC stands behind the Viejas Band of Kumeyaay Indians as the MLD and does not support the destruction of our ancestral burial grounds and ceremonial places.

I DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE STATE OF CALIFORNIA THAT THE FOREGOING IS TRUE AND CORRECT AND THAT THIS DECLARATION WAS SIGNED ON MAY 10, 2010 AT ALPINE, CALIFORNIA.

Steve Banegas, KCRC Spokesman

EXHIBIT FF

MADELEINE J. HINKES, PhD
Diplomate, American Board of Forensic Anthropology
2758 Nipoma Street San Diego, CA 92106 619/889-0370

FORENSIC ANTHROPOLOGY REPORT

Padre Dam Site
Investigator: Micah Hale, ASM Affiliates
7 June 2010

On 7 June, I visited the Padre Dam site in the Lake Jennings Park area, at the request of Micah Hale and Carmen Lucas, to examine a bone fragment and determine whether it was human.

The fragment is a 1.5 x 0.9 cm fragment of calcined long bone shaft. Based on this piece, the complete bone would be of small diameter, but the morphology is not indicative of a particular bone. Based on macroscopic analysis alone, including use of a hand magnifier, it is not possible to determine with certainty if this bone is human.

Further analysis would involve destructive methods. DNA analysis is a possibility, but it is often compromised in burned bone.

In histological analysis, the bone fragment would be embedded in a medium and then thin-sectioned. The cortical bone of humans and nonhuman mammals is organized differently, and this can be seen through the microscope. This process takes one to two weeks. Since the Medical Examiner's Office does not have the equipment, I send bone to a colleague in Pomona.

Another possibility is solid-phase double-antibody radioimmunoassay, which uses protein analysis to distinguish species. I do not know of a local lab which performs this test, but I can research this if needed.

Mulhern, DM and DH Ubelaker. 2001. Differences in osteon banding between human and nonhuman bone. *Journal of Forensic Sciences* 46(2):220-222.

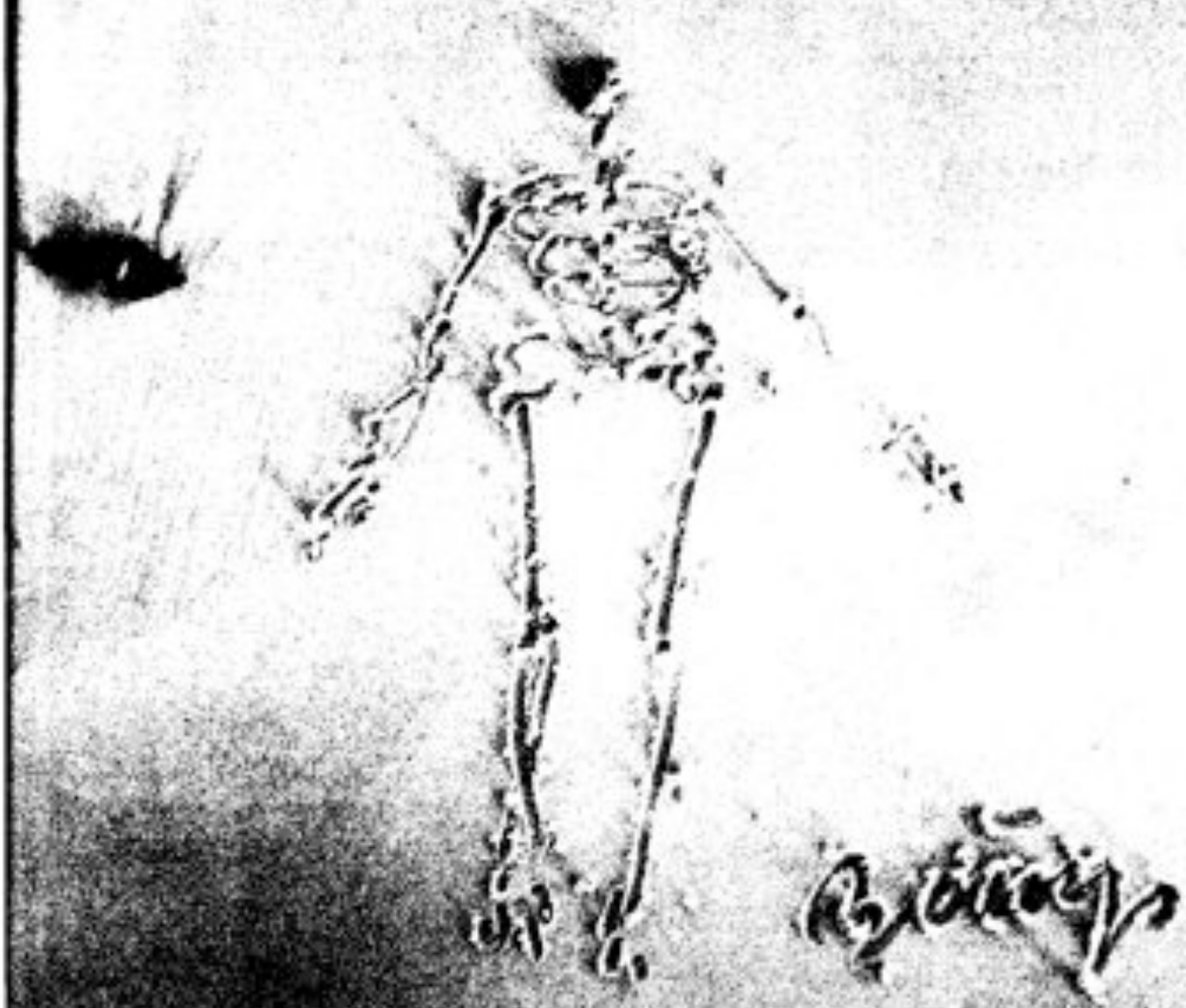
Ubelaker, DH, JM Lowenstein, and DG Hood. 2004. Use of solid-phase double-antibody radioimmunoassay to identify species from small skeletal fragments. *Journal of Forensic Sciences* 49(5):924-929.

Mulhern, DM. 2009. Differentiating Human from Nonhuman Skeletal Remains. In *Handbook of Forensic Anthropology and Archaeology*. S Blau and DH Ubelaker, eds., pp 153-163.

Madeleine J Hinkes, PhD

HANDBOOK OF FORENSIC ANTHROPOLOGY AND ARCHAEOLOGY

Edited by Soren Blau & Douglas H. Ubelaker



Series Editors: George Nicholas & Julie Hollowell

13

Differentiating Human from Nonhuman Skeletal Remains

Dawn M. Mulhern

One of the first questions faced by a forensic anthropologist is whether the remains are human or nonhuman. When complete or partial bones are present, gross analysis of morphological features can often be used to confirm or rule out human remains. Extreme fragmentation makes morphological analysis more difficult if not impossible and may require microscopic, biochemical, or DNA analysis. This chapter explores the morphological features that can be used to distinguish human from nonhuman bone and identifies the most common examples of misidentification. Next, it investigates microscopic techniques for distinguishing human from nonhuman bone. Finally, it discusses biochemical analyses.

Gross Analysis

Macroscopically and microscopically, human bone is most similar to the bone of other mammals, and therefore the most likely source of confusion is between human and nonhuman mammalian species. In a forensic context, one must take into account the local context and consider what species are most likely to be present in that area. The unique combination of a very large brain case, orthognathic face (that is, with a nonprojecting jaw), and adaptations to bipedal locomotion in humans provides many morphological differences between humans and nonhuman mammals that are useful for distinguishing individual skeletal elements. In addition to morphological differences, subadult human bones can be distinguished from adult mammalian bones that are similar in size by the presence of unfused or partially fused epiphyses. A number of sources for archaeologists provide illustrated atlases comparing and describing the differences between human and nonhuman bone (Cornwall 1956; Gilbert 1973; Olsen 1975; Schmid 1972); some of the most important differences are summarized below.

Skull

Compared to that of other mammals, the human cranial vault is very large relative to body size; also, the human cranium has a more domed shape and thinner cortex compared to that of other mammals. The frontal, temporal, and occipital bones fuse in early childhood in humans but remain as separate elements in many mammals (Cornwall 1956). In addition, the human vault exhibits gracile muscle attachment sites and lacks sagittal and nuchal crests. A notable exception is the large mastoid process, which serves as an attachment site for the sternocleidomastoid muscle that functions in swiveling and tilting the head in humans to accommodate a vertical posture. The foramen

magnum is also centrally located in the cranial base; this differs from quadrupeds, in which the foramen magnum is more posteriorly situated.

The mandible is short anterior-posteriorly in humans, resulting in a lack of prognathism. The coronoid process is only slightly higher than the mandibular condyle. In some mammals, the coronoid process is much more superiorly located compared to the condyle (horse, cow, deer, sheep, rabbit, bear, beaver) and is also located much more anteriorly in humans compared to other mammals (Schmid 1972).

Dentition

Human teeth are easily differentiated from the teeth of most other mammals owing to size and morphology. Humans exhibit small canines with apical wear, lack a diastema, and have nonsectorial premolars. Human premolars and molars have low, rounded cusps adapted to an omnivorous diet; these are easily distinguished from the teeth of herbivores and carnivores. Other mammals with similar molar form include bears and pigs; however, bears have much larger teeth than humans, and pigs have four premolars and three molars, whereas humans have two premolars and three molars. The first three premolars are sectorial (and therefore have a sharp cutting edge) in pigs and the three molars are larger than human teeth. The only possible point of confusion is between the fourth premolar in a pig and a human molar (Byers 2005).

Vertebral Column

The human spine is characterized by an S-shaped curve that accommodates a vertical posture. In addition, the vertebral bodies gradually increase in size from the superior to the inferior aspect of the vertebral column, owing to the need to support increasingly more weight. This pattern is not as dramatic in quadrupeds, since compression forces from gravity are similar throughout the spine. The number of vertebrae differs among mammals—for example, members of Order Carnivora have 1–3 more thoracic vertebrae and 1–2 more lumbar vertebrae than humans do (Cornwall 1956).

Compared to that of other mammals, the human atlas exhibits shallower occipital condyles and a much smaller distance between the facets for the occipital and axis. The human axis has a short, stout odontoid process. The spinous processes of the cervical vertebrae are often bifid in humans. In addition, spinous processes are short in humans compared with those of other mammals, because they do not support the massive musculature needed by quadrupeds in the neck and back. In humans, all the spinous processes are oriented inferiorly. Quadrupeds have an anticlinal thoracic vertebra with a vertical spinous process; all other spinous processes are inclined toward it, caudally for the cervical and upper thoracic spine and cranially for the spinous processes of the lower thoracic and lumbar spine (Cornwall 1956). Human vertebral bodies are shorter and broader compared to those of other mammals of comparable size.

Ribs

The human rib cage is broad and shallow, like that seen in apes. In general, mammals have a horizontal posture that is characterized by a narrow, deep thorax. The curvature of the ribs is therefore different in humans and most mammals, with human ribs exhibiting a more pronounced curve. Furthermore, ungulates have bony rib elements that connect the anterior end of the vertebral ribs with the sternum (Stewart 1979).

Pelvis

The morphology of the human pelvis is unique, owing to bipedal locomotion. The ilium is broad and ventrally wrapped in humans, in contrast to the elongated, dorsally located ilium in quadrupedal mammals. The pubic symphysis is rarely fused in humans. The sacrum is broad and wedge-shaped in humans; it is generally narrower in other mammals. The coccyx in humans takes the place of the tail vertebrae found in other mammals.

Shoulder Girdle

The human clavicle is long and robust, because the upper limbs are located on the sides of the body. The retention of a clavicle is a primitive trait in mammals. In addition to primates, other mammalian orders that exhibit functional clavicles include insectivores, rodents, and bats. Although ape clavicles are similar in size and morphology to human clavicles, mammals that are most likely to be found in a forensic context and that would potentially be confused with humans based on size either have reduced clavicles or lack clavicles completely.

The human scapula is triangular in shape, with a large infraspinous fossa. Nonhuman scapulae exhibit a much smaller postspinous fossa relative to the size of the bone. Also, the human scapula is longest perpendicular to the spine, whereas other mammals exhibit scapulae that are longest along the axis of the spine (Figure 13.1).

Figure 13.1 Scapula of an adult human compared with a black bear, large dog, hog, deer, domestic sheep, and small dog (*left to right*) (photos previously published in Ubelaker 1989 as Fig. 63; courtesy D. H. Ubelaker and Taraxacum Press).

Figure 13.2 Humerus of an adult human compared with a black bear, large dog, hog, deer, domestic sheep, and small dog (*left to right*) (photos previously published in Ubelaker 1989 as Fig. 63; courtesy D. H. Ubelaker and Taraxacum Press).

Long Bones

In general, long bones in humans are more slender and are not as rugose (that is, exhibit less pronounced muscle markings) than long bones in other mammals. The articular surfaces of human long bones are also flatter with less of a sculpted appearance than other mammalian bones (Figures 13.2 and 13.3). The head of the humerus in humans is hemispherical, allowing a wide range of motion in the shoulder. This feature is found in nonprimates, but other mammals have flatter humeral heads. The greater tubercle of the humerus is small in humans but is very prominent, whereas in other mammals, such as cows, deer, sheep, and pigs, the tubercle extends superiorly to the humeral head. The capitulum is prominent in the human humerus, to accommodate the enhanced mobility of the radial head. In most quadrupeds, the radius also articulates with the trochlea. The coronoid process is more prominent and the olecranon fossa is less prominent

Figure 13.3 Radius and ulna of an adult human compared with a black bear, large dog, hog, deer, domestic sheep, and small dog (*left to right*) (photos previously published in Ubelaker 1989 as Fig. 63; courtesy D. H. Ubelaker and Taraxacum Press).

in humans than in quadrupeds. A supratrochlear foramen is found in pigs, wolves, foxes, bears, and rabbits. An entepicondylar foramen is present in some mammals, such as raccoons, weasels, otters, pumas, and bobcats (Cornwall 1956; Olsen 1973). The human ulna has a very short olecranon process, again allowing a wider range of motion in the elbow than typical of most mammals. In quadrupeds, the olecranon process is extended, providing more leverage for the triceps. The radius and ulna are fused together in some mammals, such as the goat, horse, and pig (Olsen 1973).

The femur is long and the shaft is medially angled in humans. Compared to that of other mammals, the human femoral shaft has a smaller

Figure 13.4 Femur of an adult human compared with a black bear, large dog, hog, deer, domestic sheep, and small dog (*left to right*) (photos previously published in Ubelaker 1989 as Fig. 63; courtesy D. H. Ubelaker and Taraxacum Press).

Figure 13.5 Tibia of an adult human compared with a black bear, large dog, hog, deer, domestic sheep, and small dog (*left to right*) (photos previously published in Ubelaker 1989 as Fig. 63; courtesy D. H. Ubelaker and Taraxacum Press).

circumference for its length. The human femur exhibits a robust head and a long neck. The angle between the neck and the shaft is greater in humans compared to most quadrupedal mammals (Figures 13.4 and 13.5). The attachment site for the leg extensors, *linea aspera*, is well developed in humans (Cornwall 1956). A lateral lip is present on the anterior aspect of the distal femur; this feature of the distal articular surface helps hold the patella in position during the force of a striding gait. The proximal and distal articular surfaces of the tibia are flat and platform-like, to accommodate the weight of a biped. The tibia and fibula are fused together in some mammals but not in those that would generally be confused with human.

Hands and Feet

Unlike most mammals, humans retain the primitive trait of five digits. The heads of the metacarpals and the metatarsals are rounded, allowing extensive mobility of the digits. The articular surfaces

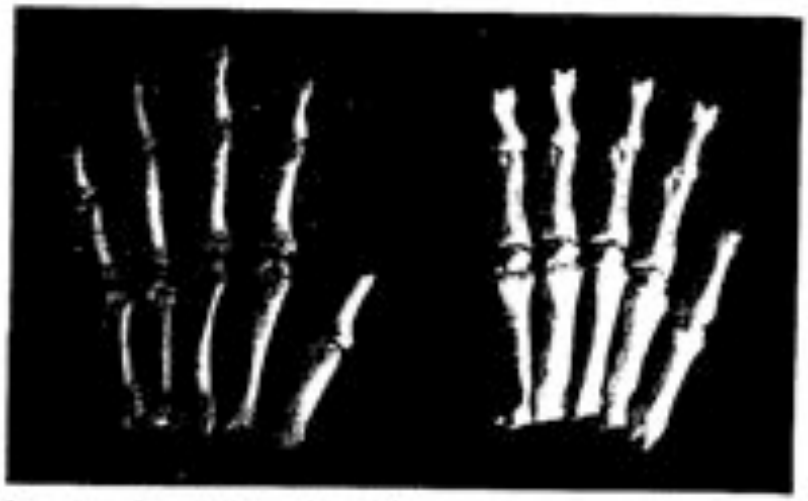


Figure 13.6 Comparison of an adult human hand (*left*) with the front paw of a young bear (*right*), including metacarpals, proximal and middle phalanges.

of the hand and foot phalanges in humans are flatter than in other mammals and lack a median ridge. The first digit of the human hand is opposable. The first metatarsal is more robust than the other metatarsals in humans. The tarsal bones in humans are robust owing to bipedal locomotion. In particular, the talus has a very flat, platform-like superior articular surface.

Bear paws and human hands and feet exhibit similarities that may lead to confusion, particularly in cases where a bear paw is partially fleshed and lacks the claws (Stewart 1979). Bears exhibit larger carpals than humans, with a fused navicular and lunate. In the hand, the second or third metacarpal is longest in the human, whereas the fourth metacarpal is longest in the bear (Stewart 1979). The differences between the metacarpals and the phalanges of a human and bear are shown in Figure 13.6, on the previous page.

In the foot, the first human metatarsal is more robust than the others, whereas in the bear all five metatarsals are comparable in robusticity. The second metatarsal is longest in humans, and the fourth metatarsal is longest in the bear (Gilbert 1975). The distal ends of the phalanges exhibit deeper grooves in the bear. Bears also exhibit sesamoid bones on the heads of all of the metacarpals and metatarsals, whereas humans typically have sesamoid bones only on the head of the first metatarsal (Hoffman 1964).

Radiographic Analysis

Chibuzquer and colleagues (1987) conducted a comparative radiographic analysis of long bone patterns in human and nonhuman bones. They found that the trabeculae of the spongy bone in human long-bone midshafts define spaces with a circular or oblong pattern and sometimes show homogeneous but sparse distribution, whereas the trabecular pattern in nonhuman bone is more homogeneous and dense. In addition, human bone often lacks a clear border between the cortical and the trabecular bone, whereas a well-defined border is often present in nonhuman bone. Finally, nonhuman bones are characterized by small, spicule-like invaginations from the cortex into the trabecular bone and the penetration of nutrient canals into the midshaft. A test of this method on 20 samples resulted in the correct classification in 86.8% cases by archaeologists and 81.5% by dentists (ibid.).

Microscopic Analysis

Extreme fragmentation of skeletal remains poses a significant problem in a forensic context, even in terms of determining whether the bones are human. Microscopic analysis may provide useful information in differentiating human from nonhuman bone when gross differences are not observable. Differences in bone microstructure among species have been recognized in numerous studies dating back to the mid-19th to the early 20th century, ranging from a study of vertebrates by Quekett (1849) that included several histological drawings to a comparative histological atlas by Foote (1916), which included low magnification drawings of hundreds of specimens. Enlow and Brown (1956, 1957, 1958) published a large comparative study identifying the histological patterns observed in major vertebrate groups, including both fossil and recent taxa. This large study, although the most comprehensive of its kind, is descriptive. For the past several decades, quantitative assessments of histological variables in mammalian bone[1] and human bone[2] have also contributed to the comparative literature.

The overall pattern of bone microstructure may be useful in a forensic context, particularly in ruling out human bone. Mammalian bone includes both lamellar and fibrolamellar (also called plexiform, or laminar) bone. Lamellar bone may be observed as concentric layers of bone around the outside and the inside of the bone circumference, or as discrete units of concentric layers surrounding a Haversian canal (also known as a Haversian system, or secondary osteon). Fibrolamellar bone is characterized by a network of woven bone that is laid down quickly and filled in more slowly by lamellar bone, often resulting in a regular, rectangular pattern (Figure 13.7).

Large mammals including many artiodactyls (for example, cows, sheep, pigs, and deer) have bone diameters that grow quickly and exhibit mostly fibrolamellar bone, with Haversian bone primarily near muscle attachments. Sometimes the blood vessels in fibrolamellar bone anastomose and are surrounded by layers of lamellar bone, resulting in the creation of primary osteons (Currey 2002). Primary osteons are distinguished from secondary osteons by the lack of a reversal line. As illustrated in Figure 13.8, the arrangement of these primary osteons is often linear, with multiple rows, or bands, of these structures. The primary osteons may also eventually be replaced by some secondary osteons. This pattern is common in mammalian bone but uncommon in human bone (Mulhern and Ubelaker 2001).

Ubelaker (1989) used the presence of osteon banding to identify a large bone fragment as nonhuman. The fragment was initially identified by authorities as human, because it had a

Figure 13.7 Sheep femur showing plexiform, or fibrolamellar bone.

Figure 13.8 Fibrolamellar bone, including osteon banding in the femur of a miniature swine.

pseudoarthrosis held together with a surgical plate. Microscopic analysis of the fragment revealed a pattern of alternating osteon bands, including both primary and secondary osteons, and lamellar bone. The fragment was most likely from a large dog, with the surgical work performed by a veterinarian.

Foote (1916) reports the distribution of bone types as important bone structures in nonhuman mammalian bone ($n = 155$), adult human bone ($n = 139$), and human fetal bone ($n = 7$). Lamellar bone is an important structure in 69% of the nonhuman sample, 92% of the adult human sample, and 100% of the fetal human sample. Plexiform bone is an important structure in 50% of the nonhuman bone, 8% of the adult human bone, and 100% of the fetal human bone. Haversian systems are important in 82% of the nonhuman sample, 100% of the adult human sample, and 0% of the fetal human sample. Plexiform bone is more common in nonhuman mammals; however, one should note that it is commonly found in fetal human bone. Although Foote provides drawings of plexiform bone in the adult sample, the occurrence of this pattern in adult humans is very rare and is not reported elsewhere in the literature.

In general, large mammalian bones that could be confused with human bones based on size can be ruled out as human if the overall pattern is plexiform, including a more laminar structure or the presence of multiple osteon rows, or bands.

As indicated in Foote's research, Haversian systems are common in both human and nonhuman bone. In primates and carnivores, for example, Haversian bone generally replaces primary bone (Currey 2002). Haversian systems can be isolated, scattered or densely packed, depending on various factors, including chronological age and mechanical demands. If such a pattern is encountered and plexiform bone is absent, human bone cannot be ruled out. Haversian bone is shown in Figure 13.9.

An obvious question is whether microstructural variables, such as osteon number or size, could be used to distinguish different species. Osteon density is partially age dependent and therefore a poor candidate for distinguishing interspecies differences. Differences in microstructural measurements including osteon size and Haversian canal size need to be explored further. The current literature includes a number of quantitative studies on nonhuman bone including taxa that could be important in a forensic context (Albu, Georgia, and Georgeneau 1990; Georgia et al. 1982; Jowsey 1966; Martiniaková, Vondrášková, and Fabiš 2005; Mori et al. 2005), but most have very small sample sizes. In addition, many of these studies report different dimensions requiring conversion to a common variable for comparison. A comparative study by Jowsey (1966) of rats, cats, dogs, rhesus monkeys, and cows suggests that osteon size increases with body size, but sample sizes range from 2 to 6, bringing into question the results of the study. In addition, there is little overlap in the literature in the nonhuman species studied, and where overlap does exist, results are not always consistent. For example, Jowsey (1966) reported a mean Haversian canal perimeter of 85 m in the femora of 4 dogs. Georgia and colleagues (1982) found a mean Haversian canal diameter of 48.5 m in a sample of 25 dog femora. When converted to area, these values are 0.0006 mm² and 0.0018 mm², respectively. The smallest reported mean Haversian canal size in a sample of human femora ($n = 55$) is 0.0015 mm² (Singh and Gunberg 1970). This means that the value reported by Georgia and colleagues (1982) is within the lower end of the human range, but the value reported by Jowsey (1966) falls outside the human range. Additional studies are needed for all nonhuman taxa, particularly those like the dog with such extensive variability in body size. Caution should be exercised when citing such studies in a forensic case.

Owsley, Mires, and Keith (1985) used bone microstructure to help determine the origin of several unknown bone fragments that potentially belonged to a homicide victim. The suspect in the case claimed that the bone fragments found in his truck belonged to a deer that he had shot. The bone fragments from the truck were compared with bone from the victim's humerus as well as a deer humerus. Osteon density and Haversian canal diameter were consistent with the human bone and

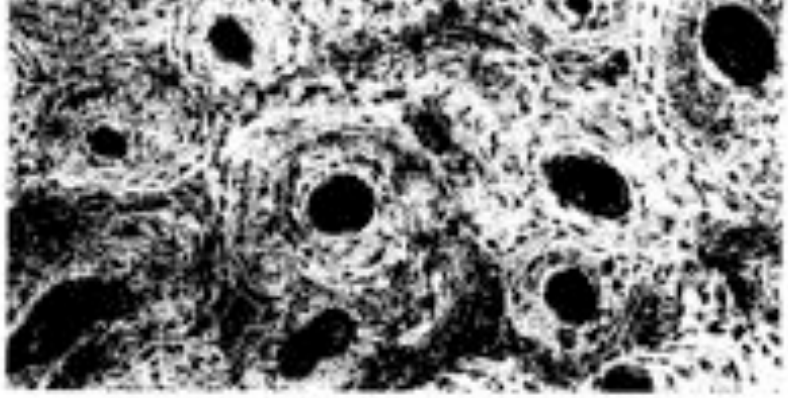


Figure 13.9 Haversian bone in an adult human femur.

inconsistent with deer bone. In this case, the comparison with the victim was important, because the values for osteon density and Haversian canal diameter observed in the deer do not fall outside the human range, but they were not comparable to this particular individual.

In a case involving numerous, small unknown bone fragments, Stout and Ross (1991) used cortical thickness and a lack of plexiform bone to rule out bone from larger mammals and used osteon size to rule out dog bone. Further, the cortical thickness and the orientation of the osteons suggested that the fragments were from the skull. This information, in conjunction with evidence from DNA and chemical analysis, was used to convict the murder suspect, even though the body of the victim was never recovered.

Cattaneo and colleagues (1999) found that quantitative microscopy was more accurate than standard microscopy and more reliable than immunological and DNA techniques for distinguishing human and nonhuman bone subject to burning. Discriminant function equations were developed for microstructural variables, including osteon and Haversian canal dimensions, based on the humeri and femora of 15 human bones and 20 nonhuman bones, including 5 cows, 6 sheep, 6 pigs, 1 horse, 1 dog, and 1 cat. The test sample of 11 human bones and 10 nonhuman bones (4 cows, 2 horses, 2 pigs, and 2 sheep) resulted in correct classification of all samples. The best discriminating factor was Haversian canal size. Standard morphological analysis resulted in the incorrect classification of 1 human bone as nonhuman and 1 nonhuman bone as human. The presence of human albumin was detectible in 5 out of 11 burned human bones, although it was detectible in all 11 unburned control samples. Mitochondrial DNA was not detectible in any of the burned bones, although it was present in all of the unburned control samples.

Biomolecular Methods

Biomolecular methods are also potentially important for distinguishing human and nonhuman bone and are useful for identifying species. Ubelaker, Lowenstein, and Hood (2004) applied a technique developed by Lowenstein (1980) for identifying human albumin to a sample of 3 human and 3 nonhuman bones. The technique involves extracting protein from the bone and then conducting a solid-phase double-antibody radioimmunoassay. Rabbit antisera were exposed to albumins or sera from different known species. The resulting species-specific antibodies were then allowed to bind to antigens in the bone protein samples. Radioactive antibodies were used to identify the strongest reactions, which indicated species-specific relationships. All 6 samples were correctly identified as human or nonhuman, although some protein depletion was noted in the 1 human sample of archaeological bone. In addition, a deer sample was tested for species-level identification and was successfully distinguished from other nonhuman species, including cow, deer, dog, goat, and pig. One benefit of this method is that only a small bone sample (200 mg or less) is required.

Techniques involving repetitive mitochondrial DNA markers have been used successfully in wildlife forensics for identifying the species of an unknown sample, including a variety of game and commercial species such as pig, cow, sheep, deer, moose, elk, bear, and turkey (Guglich, Wilson, and White 1994; Murray, Clymont, and Strobeck 1995). Techniques that apply the use of restriction enzymes are potentially preferable to DNA sequencing methods, because they are faster and more cost-efficient.

Conclusion

Depending on the extent and the preservation of the remains present, a variety of methods are available for distinguishing human and nonhuman bone. As the least invasive and most cost-effective choice, gross analysis should be attempted first. In many cases, the morphology of human bone can be detected, even in fragmentary remains. Specifically, an experienced osteologist can identify the evidence for a large cranium and physical features related to bipedal locomotion in human remains. If differences are not observable using gross analysis, then radiographic, microscopic, or biomolecular techniques may be required. The trabecular pattern of bone, pattern of histological structures, and size and number of histological structures have the potential to provide additional information about the origin of a bone. At present, histological methods provide a stronger basis for rejecting a particular bone as human than for identifying an unknown fragment as definitely human. Finally, biomolecular methods offer the possibility of species-specific identification. As these methods improve, they will likely prove invaluable for cases of highly fragmented remains. A thorough understanding of the benefits and limitations of each of these methods is essential for achieving the level of certainty needed in a forensic context.

Notes

1. Albu, Georgia, and Georgescuneanu 1990; Burr 1992; Georgia and Albu 1998; Georgia et al. 1982; Havill 2004; Jowsey 1966, 1968; Martiniaková, Vondrášková, and Fabiš 2005; Mori et al. 2005; Mulhern and Ubelaker 2003, 2006; Schaffler and Burr 1984; Singh, Tonna, and Gandel 1974.
2. Cho et al. 2002; Currey 1964; Eriksen 1991; Evans 1976; Kerley 1965; Pirok et al. 1966; Singh and Gunberg 1970; Stout and Paine 1992; Thompson 1980.

References

Albu, I., Georgia, R., and Georgescuneanu, M. 1990. The canal system in the diaphysial compacta of the femur in some mammals. *Anatomischer Anzeiger* 170(3–6): 181–187.

Burr, D. 1992. Estimated intracortical bone turnover in the femur of growing macaques: Implications for their use as models in skeletal pathology. *The Anatomical Record* 232: 180–189.

Byers, S. N. 2005. *Introduction to Forensic Anthropology*. Boston: Pearson.

Cattaneo, C., DiMartino, S., Scali, S., Craig, O. E., Grandi, M., and Sokol, R. J. 1999. Determining the human origin of fragments of burnt bone: A comparative study of histological, immunological and DNA techniques. *Forensic Science International* 102: 181–191.

Chibarquer, L., Katz J. O., Glassman, D. M., Pribholda, T. J., and Cottone, J. A. 1987. Comparative radiographic study of human and animal long bone patterns. *Journal of Forensic Sciences* 32(6): 1645–1654.

Cho, H., Stout S. D., Madsen, R. W., and Streeter, M. A. 2002. Population-specific histological age-estimating method: A model for known African-American and European-American skeletal remains. *Journal of Forensic Sciences* 47(1): 12–18.

Cornwall, I. W. 1956. *Bones for the Archaeologist*. London: Phoenix House.

Currey, J. 1964. Some effects of ageing in human Haversian systems. *Journal of Anatomy* 98(1): 69–75.

———. 2002. *Bones: Structure and Mechanics*. Princeton, NJ: Princeton University Press.

Enlow, D. H., and Brown, S. O. 1956. A comparative histological study of fossil and recent bone tissues, Part I. *The Texas Journal of Science* VIII(4): 405–443.

———. 1957. A comparative histological study of fossil and recent bone tissues, Part II. *The Texas Journal of Science* IX(2): 186–214.

———. 1958. A comparative histological study of fossil and recent bone tissues, Part III. *The Texas Journal of Science* X(2): 187–230.

Eriksen, M. F. 1991. Histological estimation of age at death using the anterior cortex of the femur. *American Journal of Physical Anthropology* 84: 171–179.

Evans, F. G. 1976. Mechanical properties and histology of cortical bone from younger and older men. *Anatomical Record* 185: 1–12.

Foote, J. S. 1916. *A Contribution to the Comparative Histology of the Femur*. Washington, D.C.: Smithsonian Contributions to Knowledge 55(3).

Georgia, R., and Albu, I. 1998. The Haversian canal network in the femoral compact bone in some vertebrates. *Morphologie et Embryologie (Bucur)* 34(3): 155–159.

Georgia, R., Albu, I., Sicoe, M., and Georgescuneanu, M. 1982. Comparative aspects of the density and diameter of Haversian canals of diaphyseal compact bone of man and dog. *Morphologie et Embryologie (Bucur)* 28(1): 11–14.

Gilbert, B. M. 1975. *Mammalian Osteo-archaeology: North America*. Springfield, MO: Missouri Archaeological Society.

Guglich, E. A., Wilson, P. J., and White, B. N. 1994. Forensic application of repetitive DNA markers to the species identification of animal tissues. *Journal of Forensic Sciences* 39(2): 353–361.

Havill, L. M. 2004. Osteon remodeling dynamics in *Macaca mulatta*: Normal variation with regard to age, sex and skeletal maturity. *Calcified Tissue International* 74: 95–102.

Hoffman, J. M. 1984. Identification of nonskeletonized bear paws and human feet, in T. A. Rathbun and J. E. Buikstra (eds.), *Human Identification: Case Studies in Forensic Anthropology*, pp. 96–106. Springfield, IL: Charles C. Thomas.

Jowsey, J. 1966. Studies of Haversian systems in man and some animals. *Journal of Anatomy* 100(4): 857–864.

———. 1968. Age and species differences in bones. *Cornell Veterinarian* 58: 74–94.

Kerley, E. R. 1965. The microscopic determination of age in human bone. *American Journal of Physical Anthropology* 35: 171–184.

Lowenstein, J. M. 1980. Species-specific proteins in fossils. *Naturwissenschaften* 67: 345–346.

Martiniaková, M., Vondrášková, M., and Fabiš, M. 2005. Investigation of the microscopic structure of rabbit compact bone tissue. *Scripta Medica* 76(4): 215–220.

Mori, R., Tetsuo, K., Soeta, S., Sato, J., Kakizoe, J., Hamada, S., Takaki, H., and Naito, Y. 2005. Preliminary study of histological comparison on the growth patterns of long-bone cortex in young calf, pig and sheep. *The Journal of Veterinary Medical Science* 67(12): 1225–1229.

Mulhern, D. M., and Ubelaker, D. H. 2001. Differences in osteon banding between human and nonhuman bone. *Journal of Forensic Sciences* 46(2): 220–222.

———. 2005. Histologic examination of bone development in juvenile chimpanzees. *American Journal of Physical Anthropology* 122(2): 127–135.

———. 2006. Bone microstructure in juvenile chimpanzees. Abstract. *American Journal of Physical Anthropology* Supp. 42: 135.

Murray, B. W., Clymont, R. A., and Strobeck, C. 1995. *The Journal of Forensic Sciences* 40(6): 943–951.

Olsen, S. J. 1973. *Mammal Remains from Archaeological Sites. Part 1: Southeastern and Southwestern United States*. Cambridge, MA: Peabody Museum.

Owsley, D. W., Mires, A. M., and Keith, M. S. 1985. Case involving differentiation of deer and human bone fragments. *Journal of Forensic Sciences* 30(2): 572–578.

Pirok, D. J., Ramsey, J. R., Takahashi, H., Villanueva, A. R., and Frost, H. M. 1966. Normal histological, tetracycline and dynamic parameters in human, mineralized bone sections. *Henry Ford Hospital Medical Bulletin* 14: 195–218.

Queckett, J. 1849. On the intimate structure of bone as composing the skeleton in the four great classes of animals, viz. mammals, birds, reptiles and fishes. *Transactions of the Microscopical Society of London* 2: 40–42.

Schaffler, M. B., and Burr, D. B. 1984. Primate cortical bone microstructure: relationship to locomotion. *American Journal of Physical Anthropology* 65: 191–197.

Schmid, E. 1972. *Atlas of Animal Bones: For Prehistorians, Archaeologists and Quaternary Geologists*. Amsterdam: Elsevier Publishing Company.

Singh, I. J., and Gunberg, D. L. 1970. Estimation of age at death in human males from quantitative histology of bone fragments. *American Journal of Physical Anthropology* 33: 373–382.

Singh, I. J., Tonna, E. A., and Gandel, C. P. 1974. A comparative histological study of mammalian bone. *Journal of Morphology* 144: 421–438.

Stewart, T. D. 1950. Bear paw remains closely resemble human remains. *FBI Law Enforcement Bulletin* 20(11): 18–21.

———. 1979. *Essentials of Forensic Anthropology*. Springfield, IL: Charles C. Thomas.

Stout, S. D., and Paine, R. R. 1992. Histological age estimation using rib and clavicle. *American Journal of Physical Anthropology* 87: 111–115.

Stout, S. D., and Rosa, L. M. 1994. Bone fragments a body can make. *Journal of Forensic Sciences* 36(3): 953–957.

Thompson, D. D. 1980. Age changes in bone mineralization, cortical thickness and Haversian canal area. *Calcified Tissue International* 31: 5–11.

Ubelaker, D. H. 1989. *Human Skeletal Remains: Excavation, Analysis, Interpretation* (2nd ed.). Washington, D. C.: Taraxacum.

Ubelaker, D. H., Lowenstein, J. M., and Hood, D. G. 2004. Use of solid-phase double-antibody radioimmunoassay to identify species from small skeletal fragments. *Journal of Forensic Sciences* 49(5): 924–929.